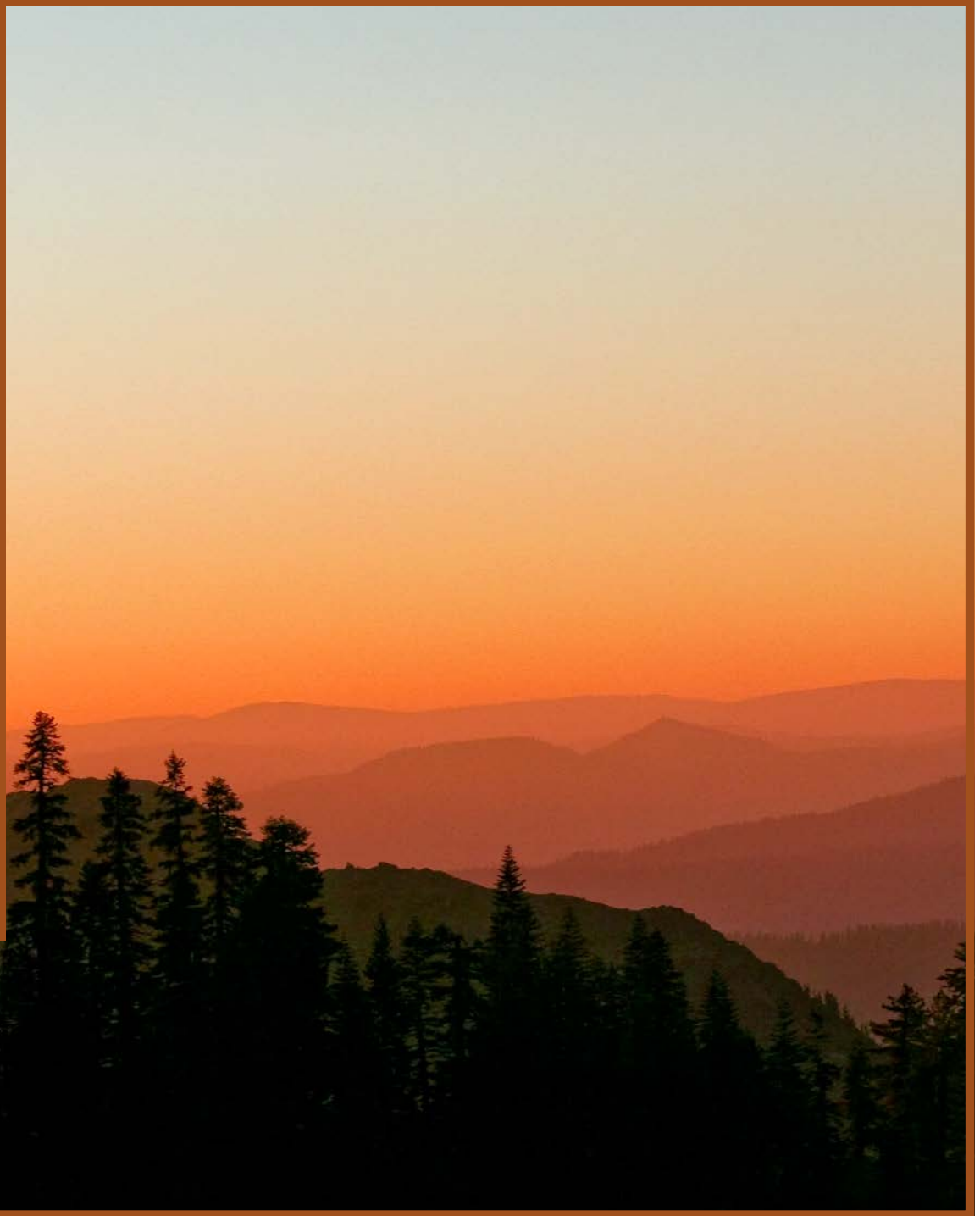


E

Earth Science
Standard
E.8.c.



Living Under One Roof

California Education and the Environment Initiative

Approved by the California State Board of Education, 2010

The Education and the Environment Initiative Curriculum is a cooperative endeavor of the following entities:

California Environmental Protection Agency
California Natural Resources Agency
California State Board of Education
California Department of Education
Department of Resources Recycling and Recovery (CalRecycle)

Key Partners:

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Office of Education and the Environment

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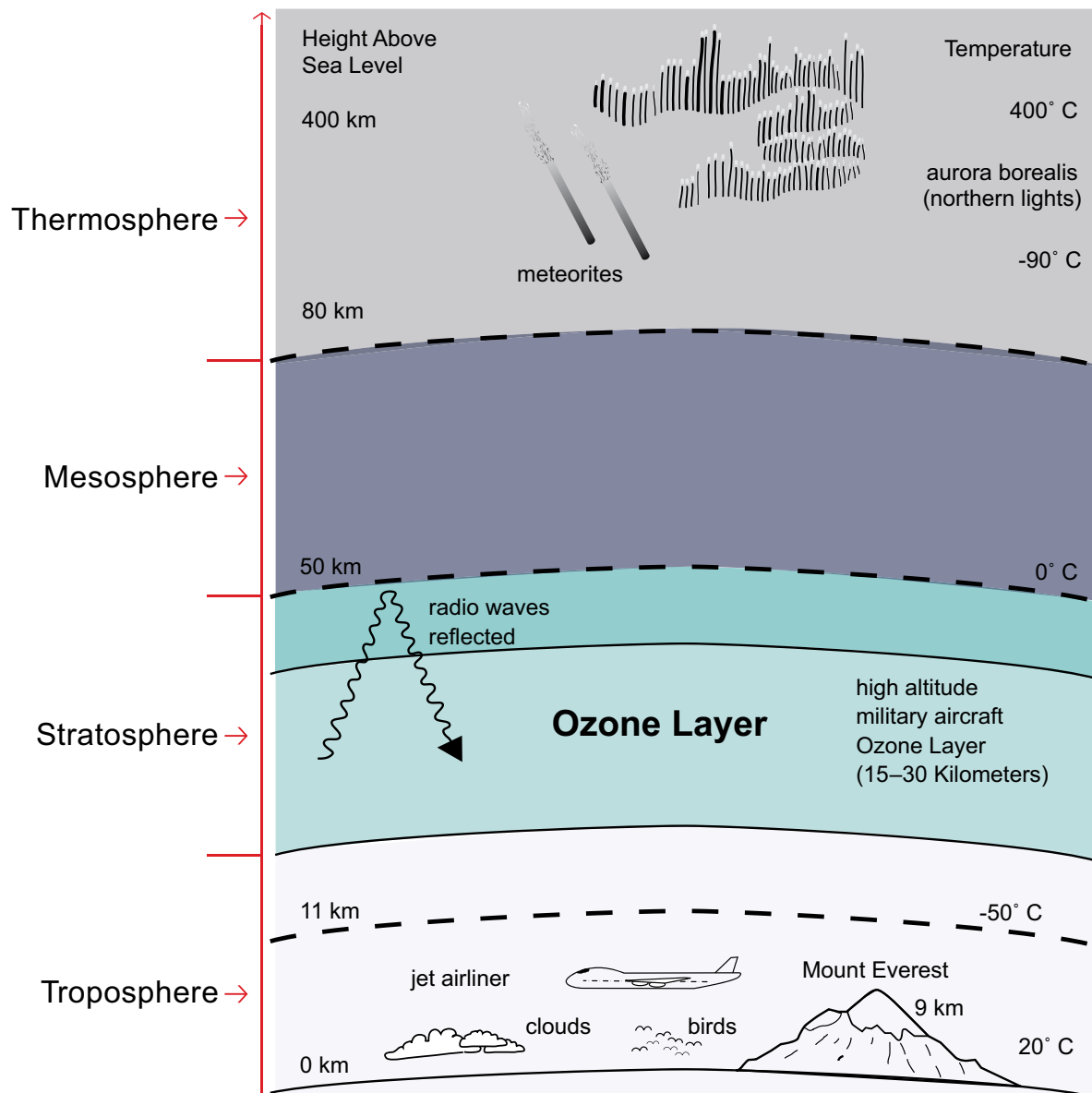
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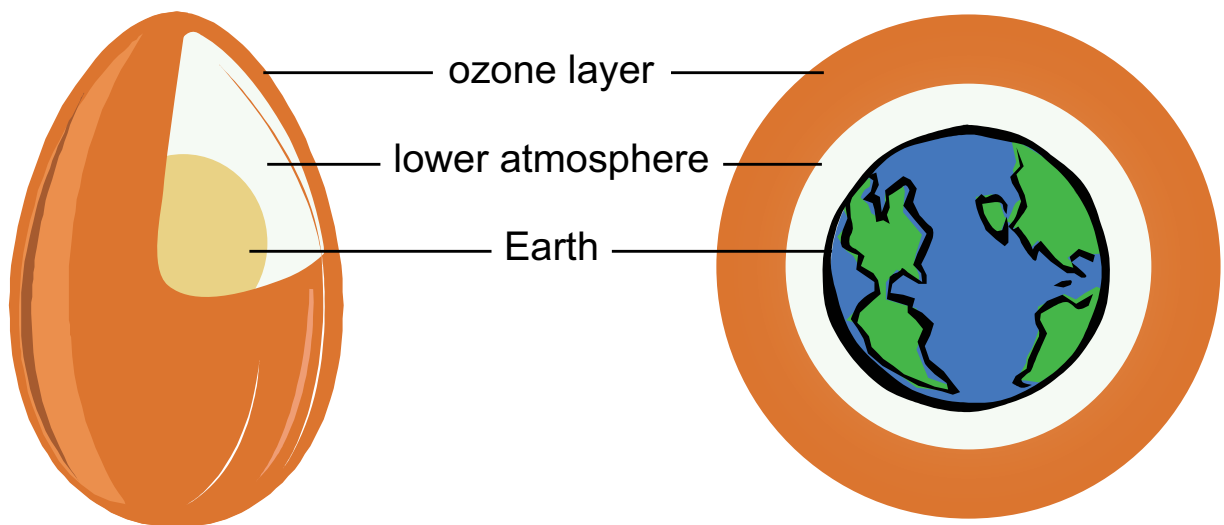
VA #1 UV Overexposure: Sunburn

VA #2 Where in Earth's Atmosphere Is the Ozone Layer?

This is the atmosphere profile averaged over the year and over Earth.



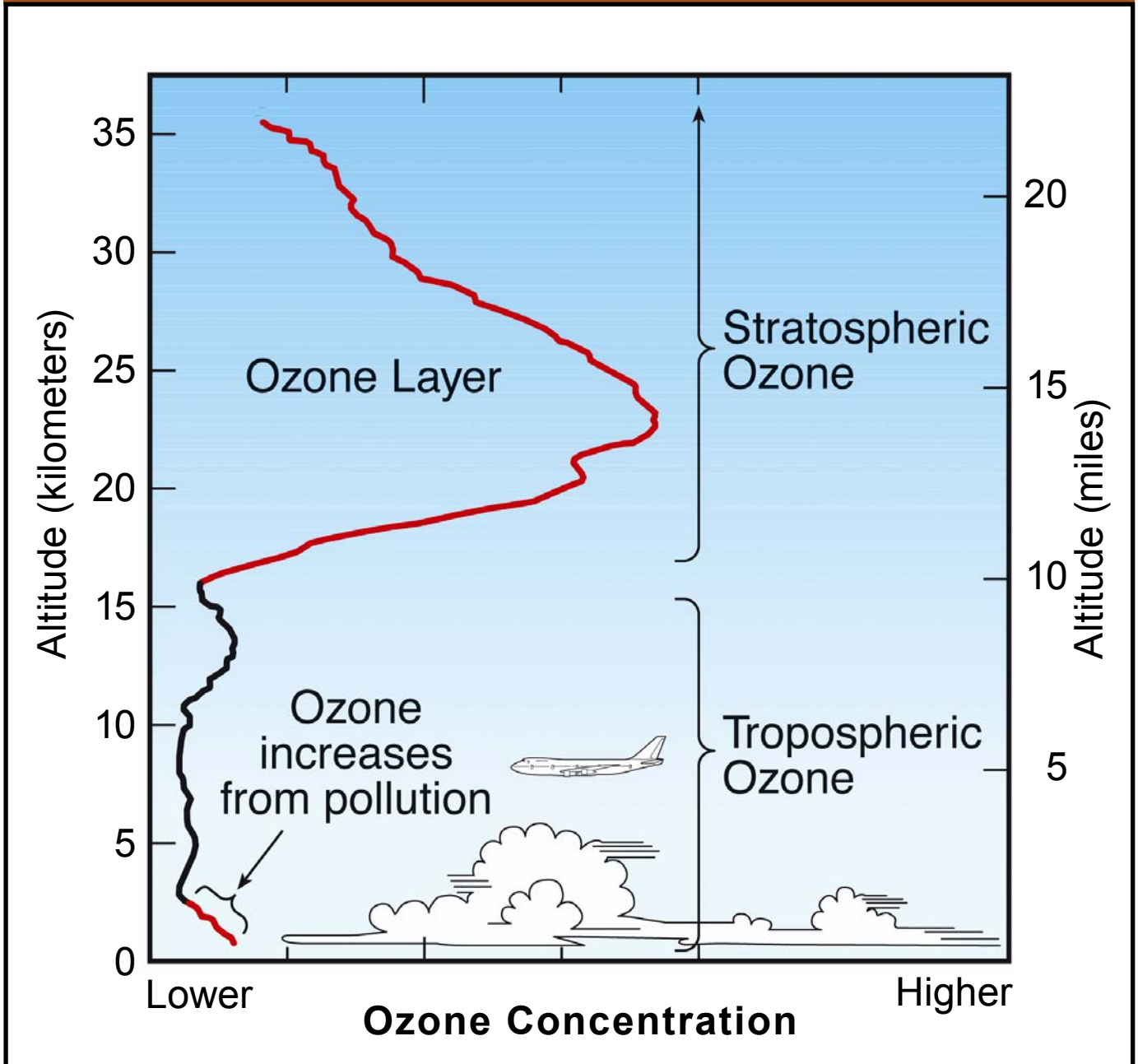
VA #3 Model of the Ozone Layer



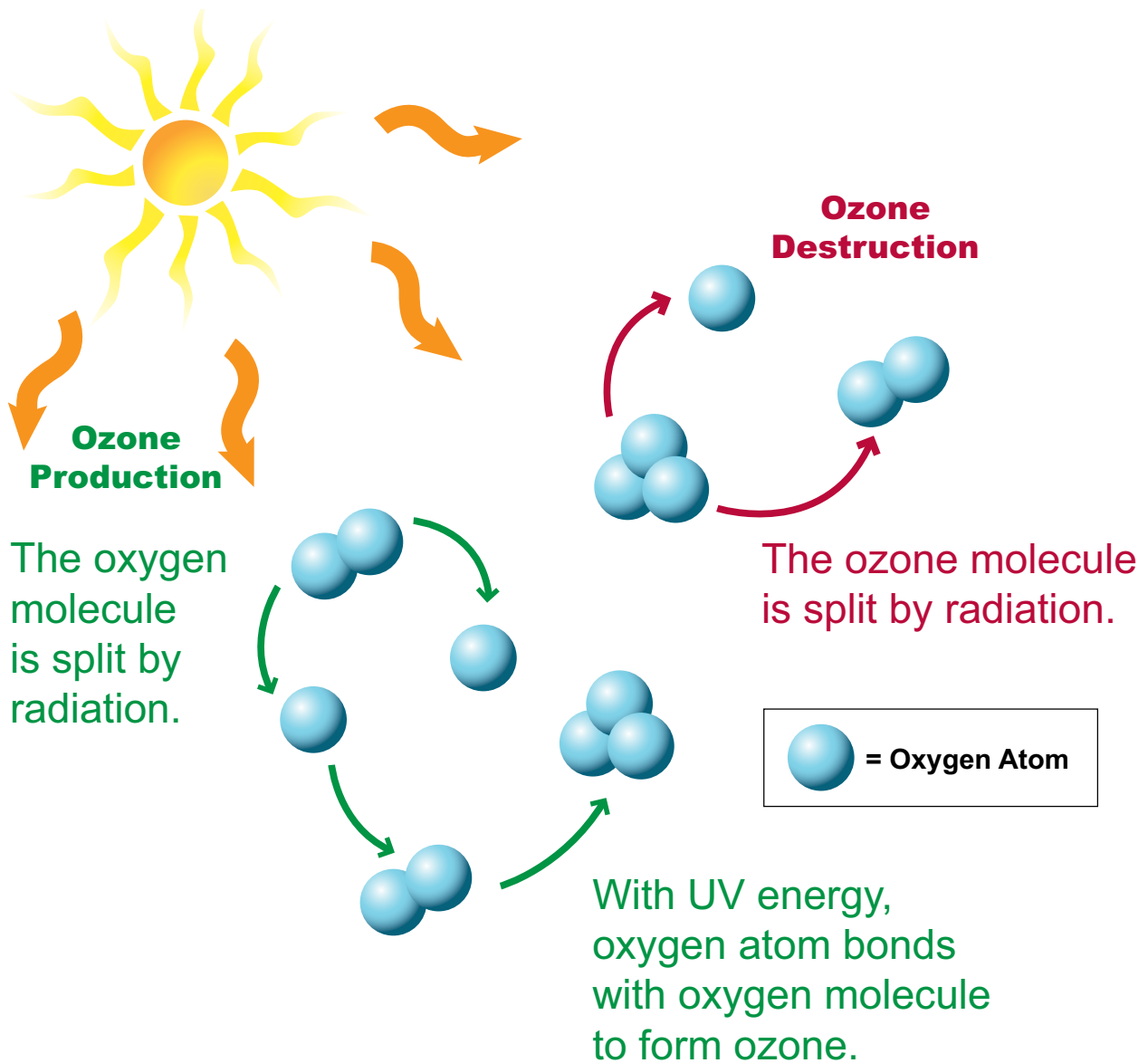
VA #4 Los Angeles Smog



VA #5 Ozone in the Atmosphere



VA #6 Natural Oxygen–Ozone Cycle



VA #7 Ozone Layer Connection

Phytoplankton

Damage to DNA causes reduced populations and/or altered species composition and may result in:

- Changes to the marine food web
- Loss of local fisheries
- Changes to ecosystem
- Loss of global fisheries
- Food shortage
- Increased hunger/starvation
- Increased cost for food

Crops

Damage to DNA causes reduced crop production, may result in:

- The need for more crop acreage
- Less native vegetation
- Reduced biodiversity
- More soil erosion
- Increased costs for growing food
- Increased cost for food
- Global food shortage
- Land competition from other demands—housing, natural areas



Human Communities

Overall, the effects of UV radiation on human health (eyes, immune system, skin) will cause an increased demand for more medical services. With aging and ever-increasing populations, demand for medical services will out weigh supply. Personal and governmental costs for health care will increase.

Cataracts & eye damage may result in:

- Demand for more community services
- Increased taxes
- Need for more doctors to perform surgery
- Tax already short supply of health care services
- Personal loss of freedom and movement

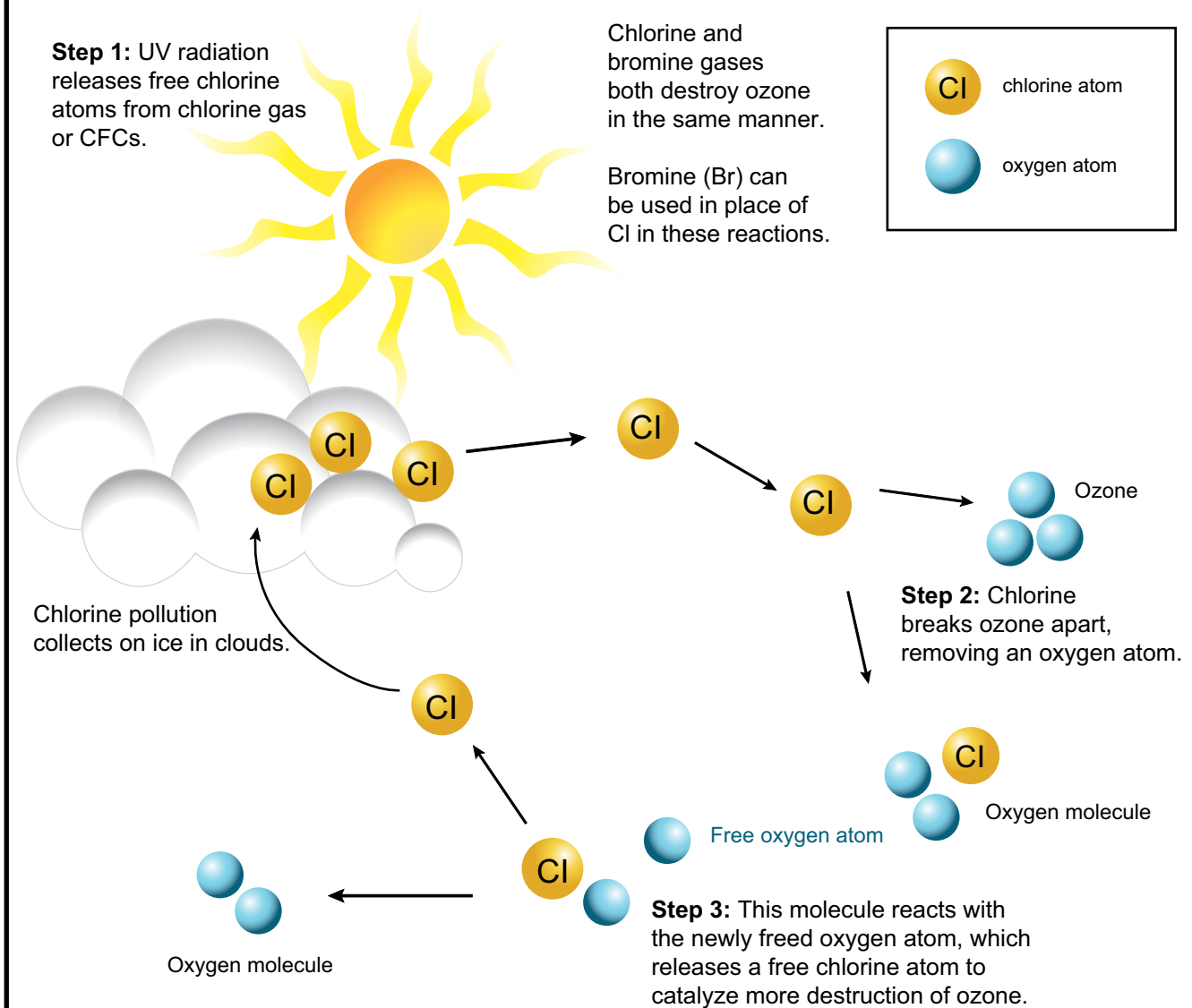
Weakened immune system may result in:

- More diseases → increased spreading of diseases
- Vaccine failure → more infectious diseases
- Return of plagues on a global level
- Increase in auto-immune diseases (HIV, arthritis, diabetes, MS)

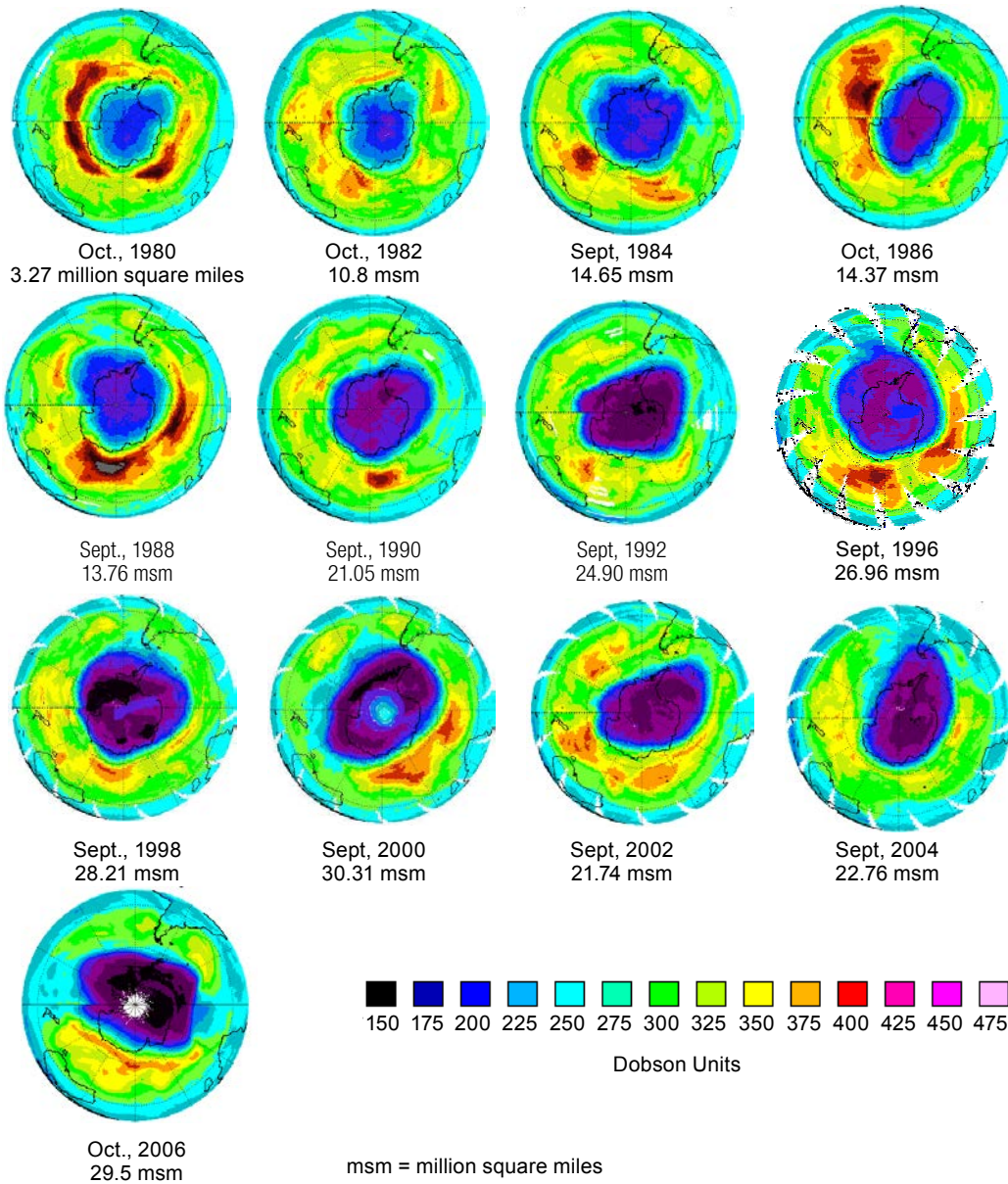
Skin Damage (DNA) may result in:

- Skin cancer → death is worst-case scenario
- Painful, costly treatment
- Premature aging/wrinkles → Self-esteem issues
- Increased demand for cosmetic treatments

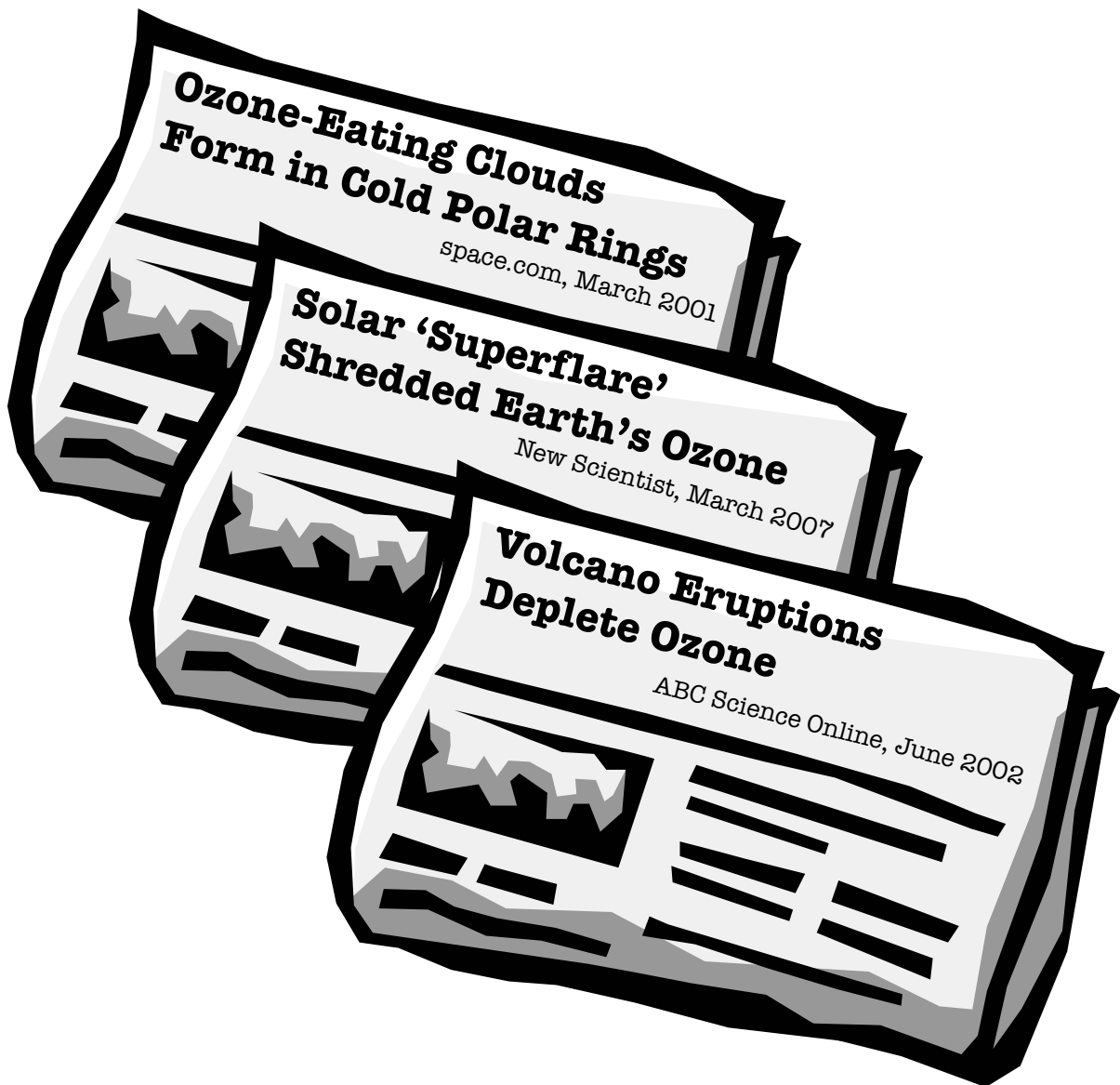
VA #8 Ozone Destruction Process



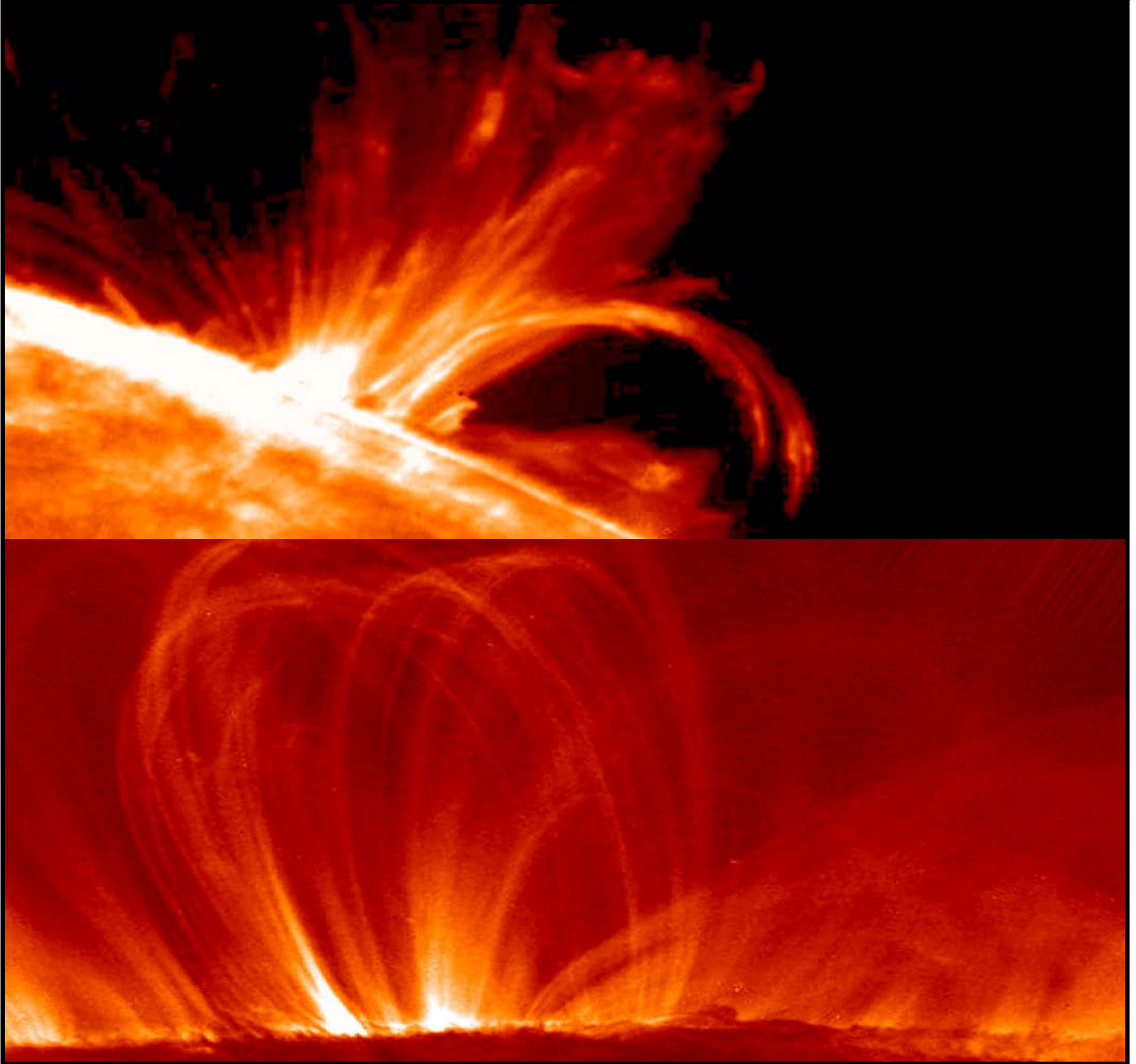
VA #9 Antarctic Ozone Hole Timeline



VA #10 Headlines about the Ozone Layer



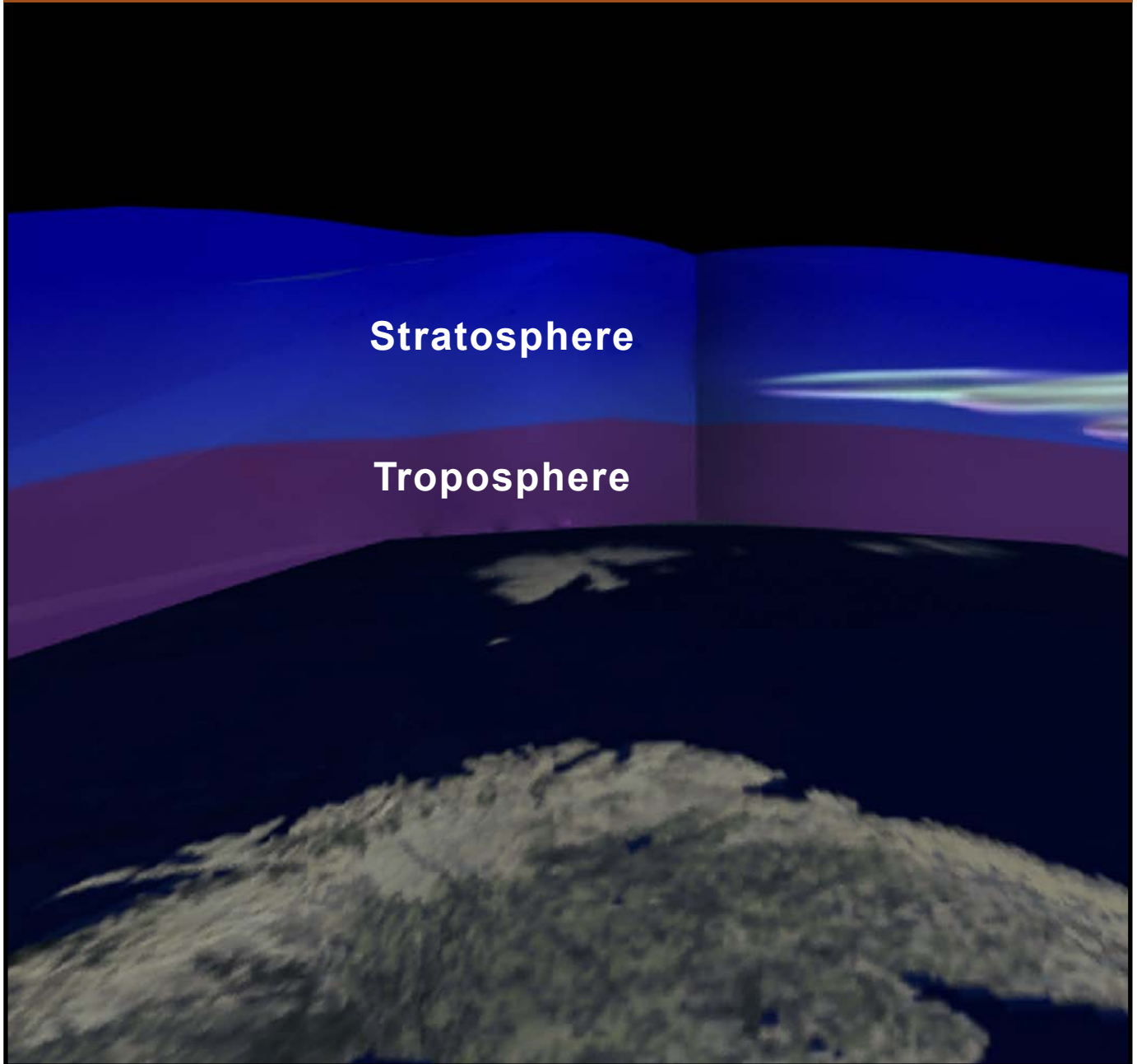
VA #11 Solar Flares



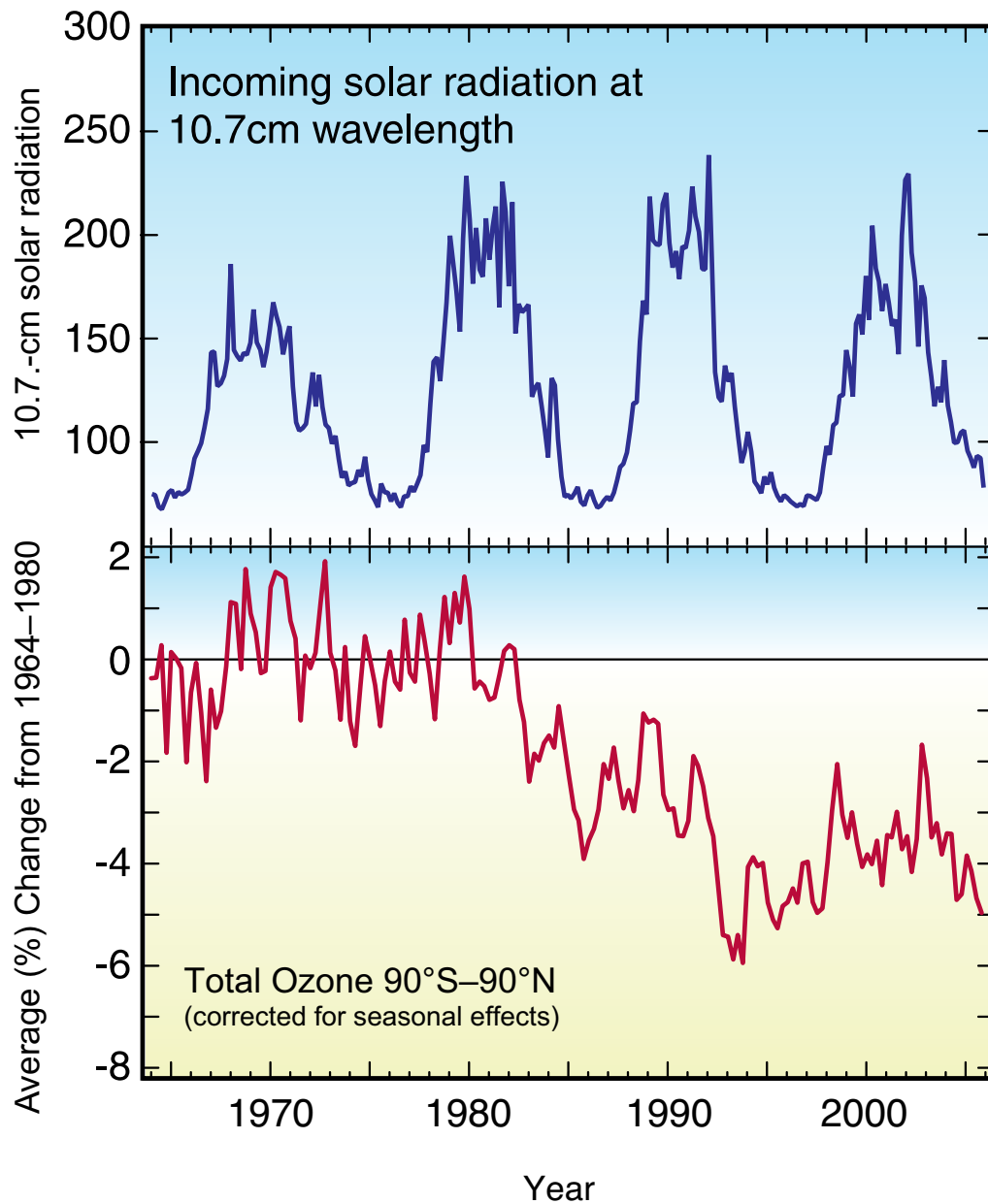
VA #12 Volcanic Eruptions

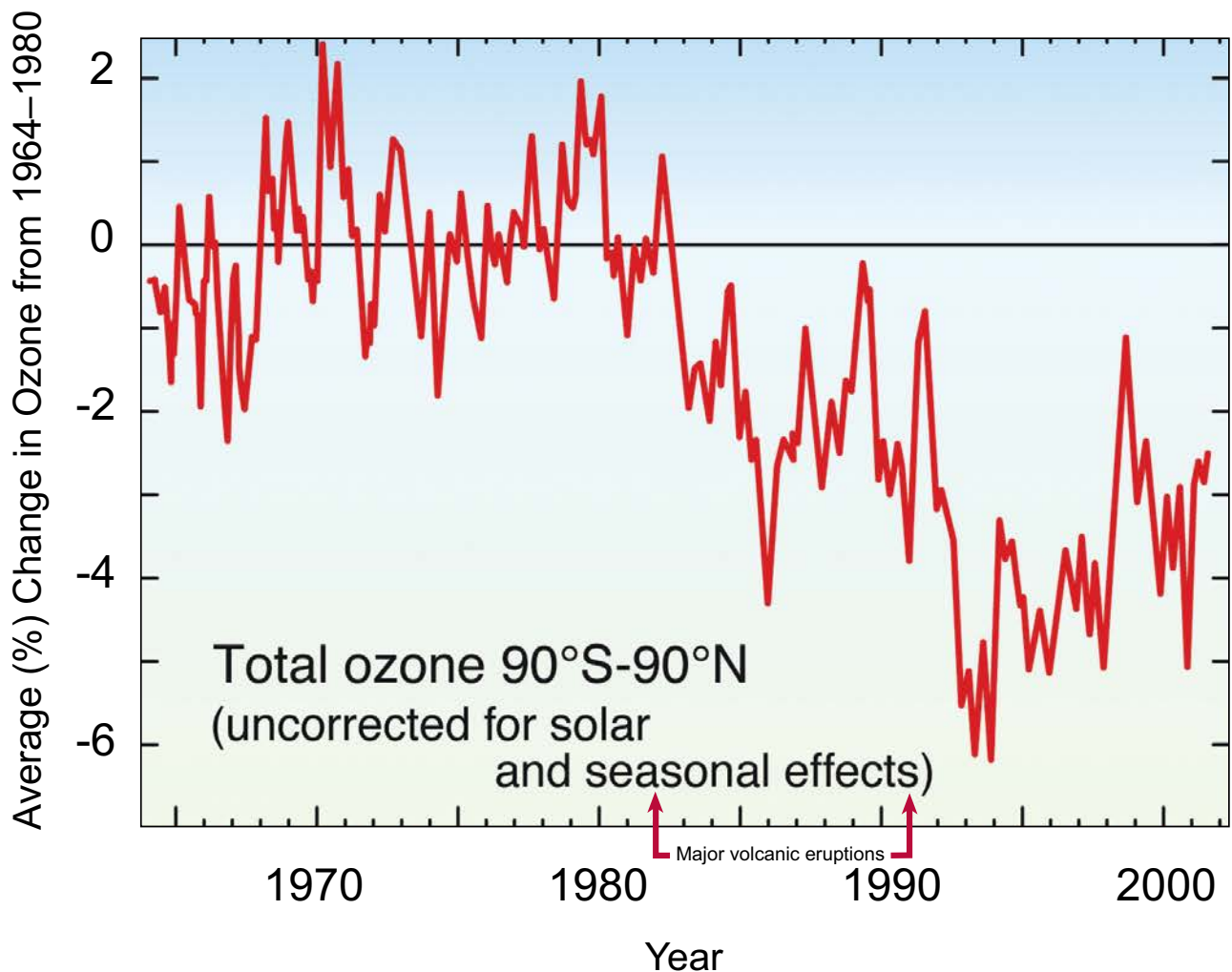


VA #13 Stratospheric Polar Clouds and the Ozone Layer

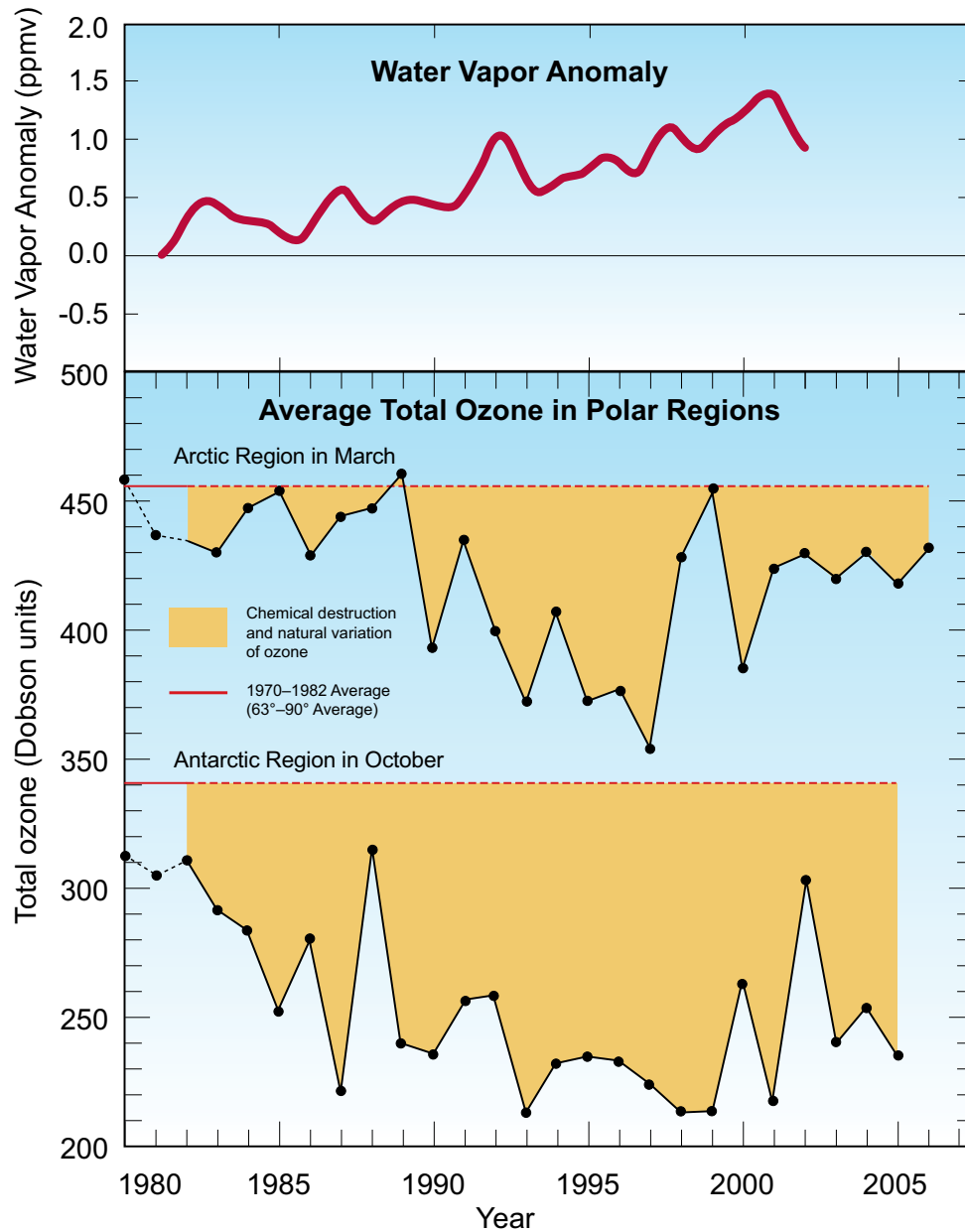


VA #14 Comparing Solar Flares to Ozone Levels



VA #15 Comparing Volcanic Eruptions to Ozone Levels

VA #16 Comparing Stratospheric Clouds to Ozone Levels



VA #17 Which Can You Live Without?



VA #18 Sources of Chlorine and Bromine Gas Emissions

Human Activities

Product/Source	Chemicals Involved	Catalyst in Ozone Destruction
Air Conditioning		
Foams		
Aerosol sprays (spray paint, hair spray, cooking spray)		
Metered Dose Inhalers		
Refrigeration and coolants		
Solvents		
Fire Extinguishers		
Pesticides		

Natural Conditions

Source	Chemicals Involved	Catalyst in Ozone Destruction
Volcanic Eruptions		
Solar Flares		
Stratospheric Polar Clouds		

VA #19 Periodic Table of Elements

																		Halogens								
1A																	8A									
1 H 1.00794 Hydrogen																	2 He 4.002602 Helium									
3 Li 6.341 Lithium	4 Be 9.012182 Beryllium																	5 B 10.811 Boron	6 C 12.0107 Carbon	7 N 14.0067 Nitrogen	8 O 15.9994 Oxygen	9 F 18.9984032 Fluorine	10 Ne 20.1797 Neon			
11 Na 22.989769 Sodium	12 Mg 24.3050 Magnesium																	13 Al 26.9815386 Aluminum	14 Si 28.0855 Silicon	15 P 30.973762 Phosphorus	16 S 32.065 Sulfur	17 Cl 35.453 Chlorine	18 Ar 39.948 Argon			
19 K 39.0983 Potassium	20 Ca 40.078 Calcium	3B	21 Sc 44.955912 Scandium	4B	22 Ti 47.867 Titanium	5B	23 V 50.9415 Vanadium	6B	24 Cr 51.9961 Chromium	7B	25 Mn 54.938045 Manganese	8B		26 Fe 55.845 Iron	27 Co 58.933195 Cobalt	28 Ni 58.6934 Nickel	1B	29 Cu 63.546 Copper	2B	30 Zn 65.38 Zinc	31 Ga 69.723 Gallium	32 Ge 72.64 Germanium	33 As 74.92160 Arsenic	34 Se 78.96 Selenium	35 Br 79.904 Bromine	36 Kr 83.798 Krypton
37 Rb 85.4678 Rubidium	38 Sr 87.62 Strontium	39 Y 88.90585 Yttrium	40 Zr 91.224 Zirconium	41 Nb 92.90638 Niobium	42 Mo 95.96 Molybdenum	43 Tc [98] Technetium	44 Ru 101.07 Ruthenium	45 Rh 102.90550 Rhodium	46 Pd 106.42 Palladium	47 Ag 107.8682 Silver	48 Cd 112.411 Cadmium	49 In 114.818 Indium	50 Sn 118.710 Tin	51 Sb 121.760 Antimony	52 Te 127.60 Tellurium	53 I 126.90447 Iodine	54 Xe 131.293 Xenon									
55 Cs 132.9054519 Cesium	56 Ba 137.327 Barium	57-71 Lanthanides	72 Hf 178.49 Hafnium	73 Ta 180.94788 Tantalum	74 W 183.84 Tungsten	75 Re 186.207 Rhenium	76 Os 190.23 Osmium	77 Ir 192.217 Iridium	78 Pt 195.084 Platinum	79 Au 196.966569 Gold	80 Hg 200.59 Mercury	81 Tl 204.3833 Thallium	82 Pb 207.2 Lead	83 Bi 208.98040 Bismuth	84 Po [209] Polonium	85 At [210] Astatine	86 Rn [222] Radon									
87 Fr [223] Francium	88 Ra [226] Radium	89-103 Actinides	104 Rf [267] Rutherfordium	105 Db [268] Dubnium	106 Sg [271] Seaborgium	107 Bh [272] Bohrium	108 Hs [270] Hassium	109 Mt [276] Meitnerium	110 Ds [281] Darmstadtium	111 Rg [280] Roentgenium	112 Uub [285] Ununbium	113 Uut [284] Ununtrium	114 Uuq [289] Ununquadium	115 Uup [288] Ununpentium	116 Uuh [293] Ununhexium	117 Uus [294] Ununseptium	118 Uuo [294] Ununoctium									
Lanthanides			57 La 138.90547 Lanthanum	58 Ce 140.116 Cerium	59 Pr 140.90765 Praseodymium	60 Nd 144.242 Neodymium	61 Pm [145] Promethium	62 Sm 150.36 Samarium	63 Eu 151.964 Europium	64 Gd 157.25 Gadolinium	65 Tb 158.92535 Terbium	66 Dy 162.500 Dysprosium	67 Ho 164.93032 Holmium	68 Er 167.259 Erbium	69 Tm 168.93421 Thulium	70 Yb 173.054 Ytterbium	71 Lu 174.9668 Lutetium									
Actinides			89 Ac [227] Actinium	90 Th 232.03806 Thorium	91 Pa 231.03588 Protactinium	92 U 238.02891 Uranium	93 Np [237] Neptunium	94 Pu [244] Plutonium	95 Am [243] Americium	96 Cm [247] Curium	97 Bk [247] Berkelium	98 Cf [251] Californium	99 Es [252] Einsteinium	100 Fm [257] Fermium	101 Md [258] Mendelevium	102 No [259] Nobelium	103 Lr [262] Lawrencium									
Alkali Metals			Alkaline Earth		Basic Metal		Halogen		Noble Gas		Non Metal		Rare Earth		Semi Metal		Transition Metal									

VA #20 Miracle Products' ODP

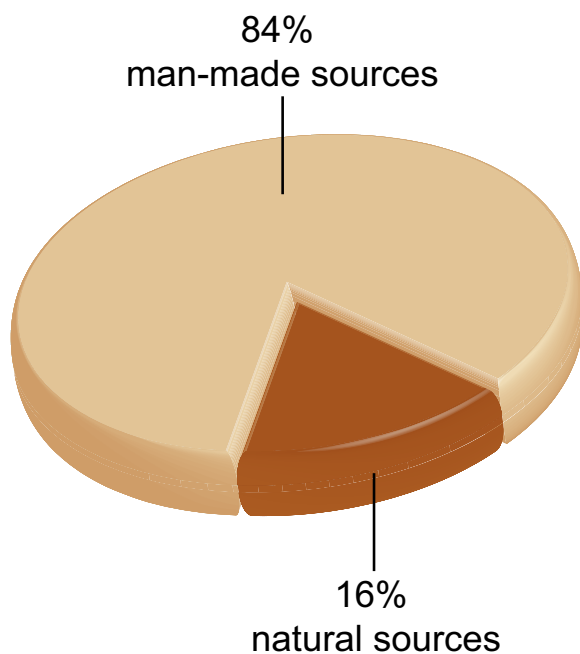
Man-made Products	Gas Emissions	Ozone-Depleting Potential (ODP)
Chlorine		
Air conditioning, coolants, foams, aerosol sprays, metered-dose inhalers, refrigeration	CFC-11	1.0
	CFC-12	1.0
	CFC-13	1.0
	HCFCs	0.02–0.12
	Carbon tetrachloride-CCl ₄	0.73
Solvents	Methyl chloroform-CH ₃ CCl ₃	0.12
Refrigeration	Methyl chloride-CH ₃ Cl	0.02
Bromine		
Fire retardants and fire extinguishers	Halon-1301	16.0
	Halon-1211	7.1
Pesticides	Methyl bromide-CH ₃ Br	0.51
Natural Sources	Gas Emissions	Ozone-Depleting Potential (ODP)
Chlorine		
Emissions from volcanic eruptions	Hydrogen chloride	Uncertain

VA #21 Stratospheric Gas Sources

Primary Sources of Chlorine and Bromine Gasses for the Stratosphere in 2004

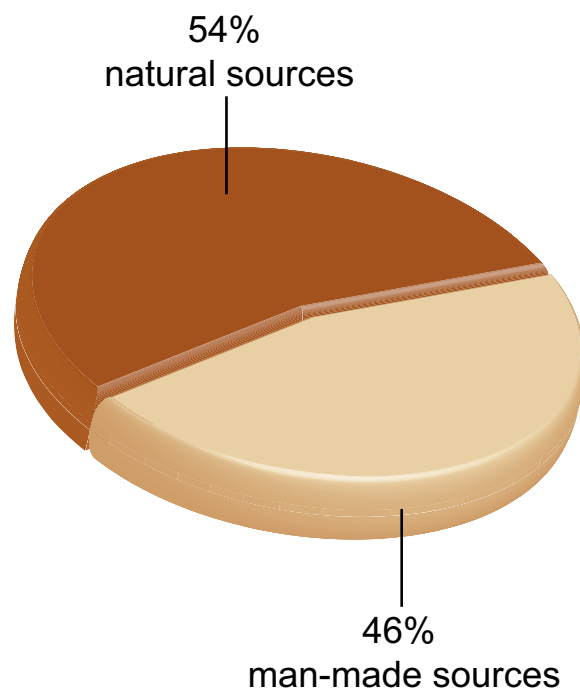
Chlorine Gasses

Total chlorine amount
= 3390 parts per trillion

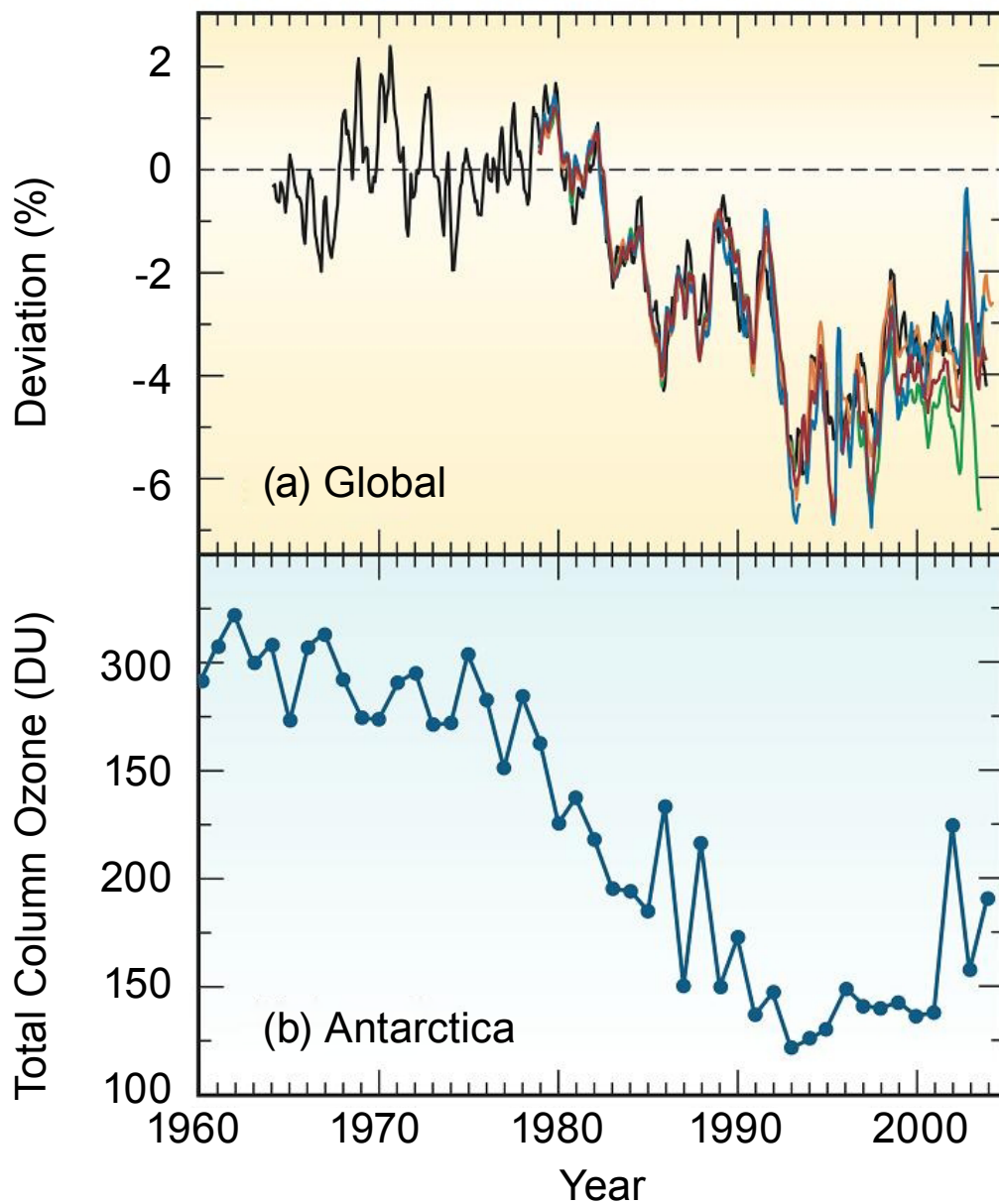


Bromine Gasses

Total bromine amount
= 21.2 parts per trillion

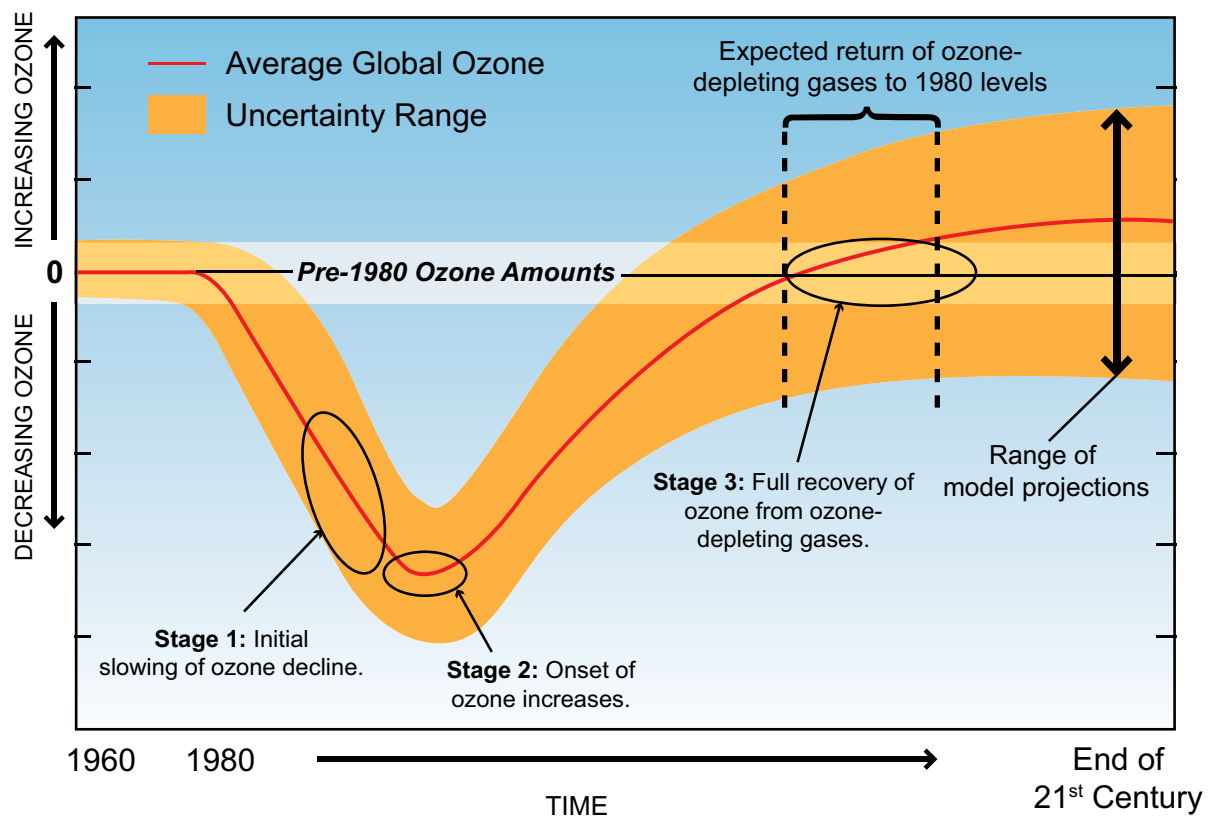


VA #22 Changes to the Ozone Layer



VA #23 Projected Recovery Stages of Global Ozone

Global Ozone Change from Pre-1980 Values



The timeline for recovery identifies three stages. The large uncertainty range illustrates natural ozone variability in the past and potential uncertainties in global model projections of future ozone amounts.

Source: <http://www.esrl.noaa.gov/csd/assessments/2006/chapters/twentyquestions.pdf>



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